THE GLASS INDUSTRY

VOLUME 21, NUMBER 7, JULY, 1940

GLASS MELTS IN THE SYSTEMS ZIRCONIA-ALUMINA-SILICA AND TITANIA-ALUMINA-SILICA

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Melts of various mixtures in the zirconia-alumina-silica and titania-alumina-silica systems were made in zircon crucibles at a temperature of 1680° C. Fragments taken from these melts were heated also in an oxyhydrogen flame and the fusion characteristics were plotted on diagrams. An apparatus was designed to measure the thermal expansion of glass fibers. Measurements showed that the melts containing zirconia possessed low thermal expansions (about 20 x 10^{-7} per degree Centigrade), while titania produced glasses with somewhat greater expansions.

Experiments have been made on the use of the oxides of zirconium and titanium in glass making and some of the properties of these glasses have been studied.[1] It seemed desirable to explore the glassy fields which would result from melting various mixtures of alumina and silica with zirconia or titania. Such information would be of use where mixtures of these oxides are incorporated in other glass melts.

The equilibrium diagrams of ZrO_2—Al_2O_3—SiO_2 and of TiO_2—Al_2O_3—SiO_2 have not been published, although information may be found on binary systems of Al_2O_3 or SiO_2 in combination with the other oxides.[2]

Experimental Method

In order to determine the fusion characteristics of mixtures of zirconia with alumina and silica and of titania with alumina and silica, weighed amounts of chemically pure materials were mixed with 3 per cent B_2O_3 (added as H_3BO_3) and placed in refractory crucibles.[3] These crucibles were then heated in a gas-fired furnace to the maximum temperature attainable (1680° C) and maintained at that temperature for one hour. During this heat-treatment, the boric oxide may be assumed to be completely volatilized, its action having been merely that of a flux in the earlier stages of melting. After the furnace had cooled, the crucibles were broken and the contents were removed.

The range of glassy compositions was extended by heating part of each of the above mixtures in an oxyhydrogen flame. Two sets of results were therefore available; first, those produced by heating at 1680° C, and second, those obtained in the oxyhydrogen flame at a temperature in excess of 2000° C.

The composition studied are shown diagrammatically in Figure 1, each field consisting of thirty trials restricted to compositions with at least 50 per cent silica.

Results of Melts

The results of melts made at 1680° C are shown in the diagrams of Figures 2 and 3. With reference to the melts containing zirconia, Figure 2 shows a small area, H, of fairly homogeneous glass with some zirconia and alumina dispersed throughout the melt. In the area V,

*The authors wish to express their gratitude to Professor C. W. Parmelee, Head of the Department of Ceramic Engineering, University of Illinois, for his helpful suggestions.

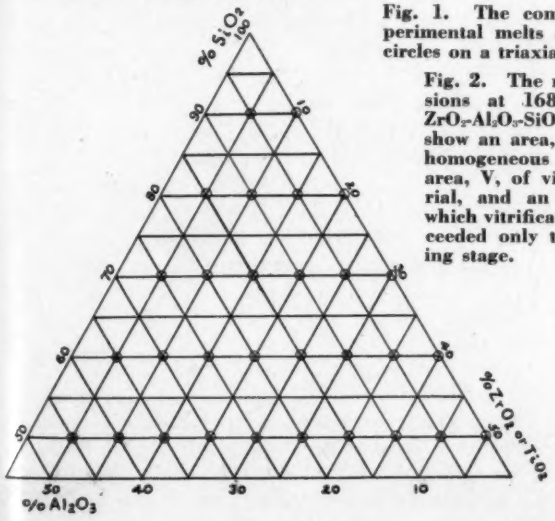


Fig. 1. The compositions of experimental melts are marked with circles on a triaxial diagram.

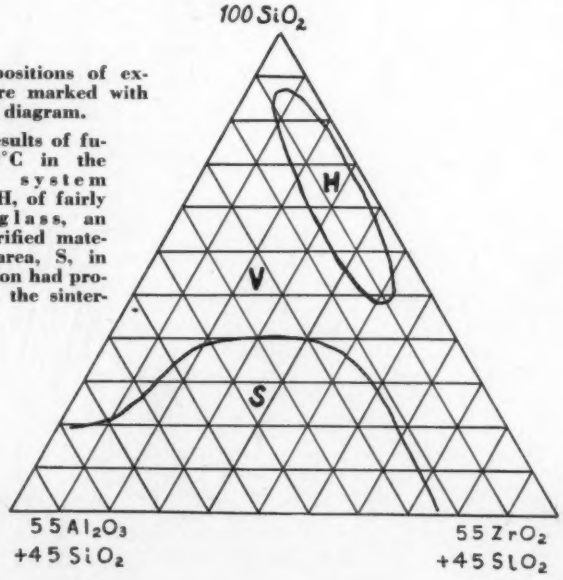


Fig. 2. The results of fusions at 1680°C in the ZrO_2-Al_2O_3-SiO_2 system show an area, H, of fairly homogeneous glass, an area, V, of vitrified material, and an area, S, in which vitrification had proceeded only to the sintering stage.

the materials formed opaque vitreous bodies, while the area S denotes mixtures in which vitrification had proceeded only to the sintering stage.

Figure 3 refers to the titania-alumina-silica melts at 1680° C. Two fairly well-defined areas were evident in this system. One area, H, toward the high-silica corner of the composition triangle, consisted of nearly homogeneous glasses containing some undissolved titania. These glasses were light blue in color due to the formation of TiO at this high temperature. The area V denotes vitreous compositions containing much undissolved material, while the subdivision XV represents compositions in which well-developed crystals of mullite were formed.

Figure 4 shows the results of fusing mixtures of zirconia, alumina, and silica in an oxyhydrogen flame with subsequent cooling in air, region C representing clear glass melts and region D devitrified melts. In working these glasses, a pronounced increase in viscosity was noted as the zirconia content increased.

Figure 5 is concerned with the titania-alumina-silica system. It gives results of fusions in an oxyhydrogen flame obtained as mentioned above. Area C represents clear glass, while D shows the region in which devitrification occurred. With constant silica, increasing titania content produced more fluid glasses.

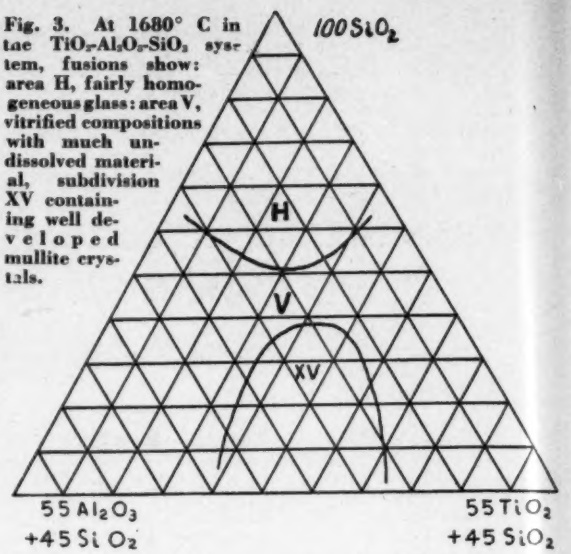


Fig. 3. At 1680° C in the TiO_2-Al_2O_3-SiO_2 system, fusions show: area H, fairly homogeneous glass: area V, vitrified compositions with much undissolved material, subdivision XV containing well developed mullite crystals.

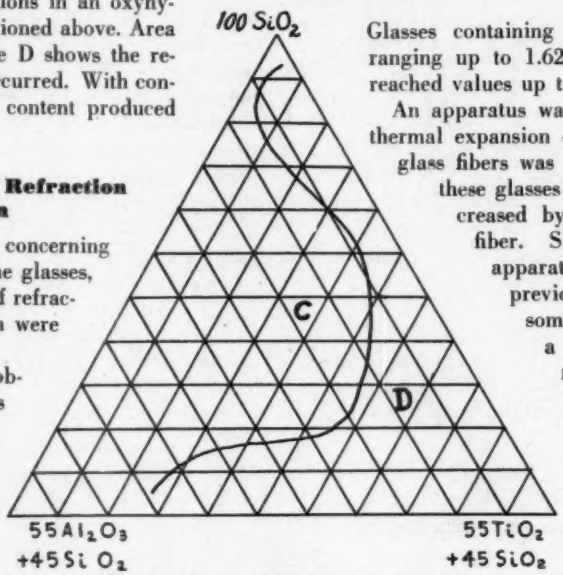


Fig. 4. The results of fusions in an oxyhydrogen flame. Area C represents clear glass melts, while area D shows the region in which devitrification occurred.

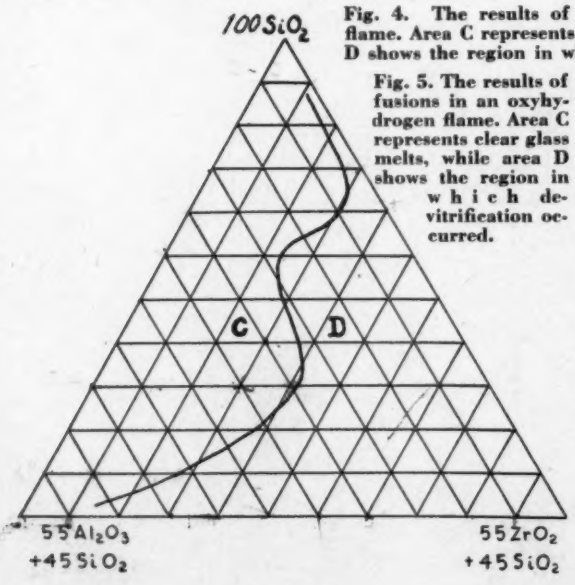


Fig. 5. The results of fusions in an oxyhydrogen flame. Area C represents clear glass melts, while area D shows the region in which devitrification occurred.

Measurement of Index of Refraction and of Thermal Expansion

In addition to the remarks concerning the property of viscosity of the glasses, some measurements of index of refraction and of thermal expansion were made.

The index of refraction was obtained by immersion in oils and observation of the Becke line under the microscope. In both series of glasses, an increase in index was noted as the silica content was reduced. Glasses containing zirconia possessed indices ranging up to 1.625, while the titania glasses reached values up to 1.650.

An apparatus was developed to measure the thermal expansion of glass fibers. The use of glass fibers was advantageous in the case of these glasses since devitrification was decreased by the quick cooling of the fiber. Since the thermal expansion apparatus has not been described previously, it will be shown in some detail. It was found to be a rapid and convenient method, the estimated accuracy being $\pm 3 \times 10^{-7}$ per degree Centigrade.

The apparatus used for the determination of the thermal expansion is shown in Figure 6. A split furnace was mounted vertically on hinges which were carried on a rigid support. The core of the furnace consisted of a split refractory tube, 12" x 1¼", insulated from the sheet steel casing with vermiculite. The winding was spiraled chromel wire which was connected to a 110 volt line. The two halves of the furnace were faced with sheet nickel to prevent scaling from these parts.

A heat resisting alloy[4] bar, B, was mounted vertically so that it would be in the center of the furnace when the latter was closed. This bar was used to support two glass fibers, one fiber being drawn from Pyrex chemical ware, the expansion of which is 33×10^{-7} per degree Centigrade, while the other fiber was drawn from the glass whose coefficient was desired.

Ames dial gauges D (.0001 inch divisions) were mounted on this bar as shown in Figure 6. The spindles of these gauges were fitted with slotted holders for the beads on the lower ends of the glass fibers. On the upper end of this bar a slotted brass plug was mounted for holding the upper beads of the fibers. One of the

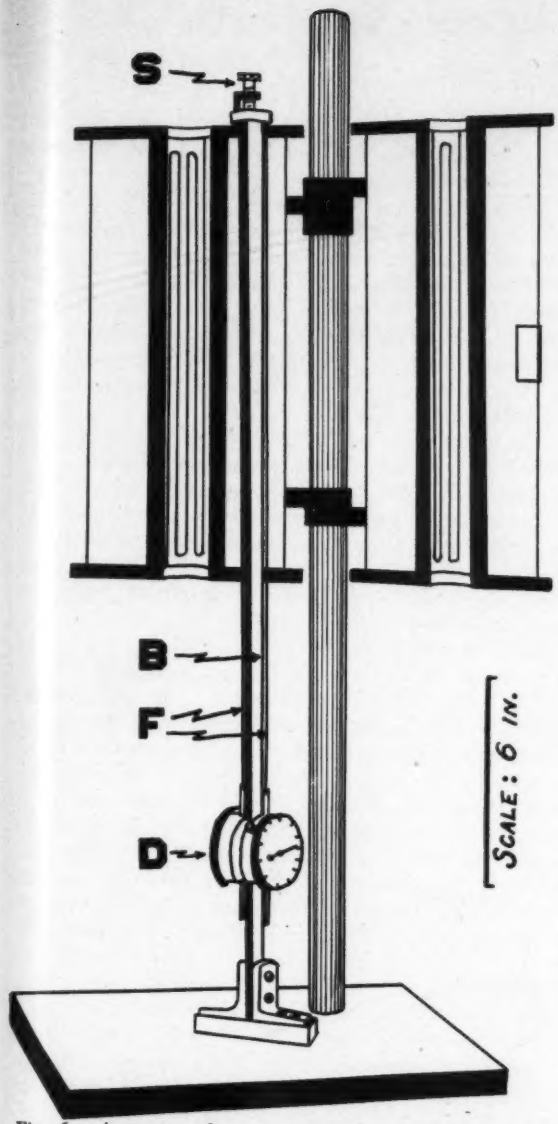


Fig. 6. Apparatus for measuring the thermal expansion of glass fibers. A standard fiber (Pyrex chemical glass) is mounted permanently while the test glass is easily placed in position. Dial gauges record the expansions of the two glasses, the coefficient of expansion of the test glass being obtained from the readings of the two gauges.

bead holders (the one in which the fiber with unknown expansion was placed) was mounted on an adjustable screw. Since the spindle of the dial gauge had a vertical displacement of 0.3", this adjustable screw allowed compensation to be made for fibers of varying lengths. Consequently, the unknown fiber needed to be only within $\pm 3/8$" of the same length as the standard fiber in order that it could be used. When the furnace was closed, the above mentioned brass plug was flush with the transite insulation on the top of the furnace; thus an updraft through the furnace was prevented and a more steady temperature was maintained.

From the above arrangement of apparatus, it may readily be shown that

$$\frac{R_x}{R_s} = \frac{1}{K_1}(\alpha_x - k_2)$$

where R_x is the change in reading of the dial gauge connected to the test glass, R_s the change in reading of the dial gauge connected to the standard fiber (Pyrex chemical glass), α_x the desired coefficient of expansion of the test glass, and k_1 and k_2 are constants, k_1 being equal to $\alpha_m - \alpha_s$ and k_2 equal to $\frac{\alpha_m}{\alpha_m - \alpha_s}$, where α_s and α_m are the coefficients of the standard glass fiber and of the metal bar, respectively.

The above equation is linear and was used in the preparation of the calibration curve of the apparatus.

The method of calibrating the apparatus was as follows: A series of fibers was drawn from glasses, the coefficients of expansion of which had been determined by the interferometer. One of these fibers (Pyrex: $\alpha = 33 \times 10^{-7}$) was selected as a standard and was used throughout the calibration of the instrument and the determination of the expansions of the unknown glasses. The standard fiber was placed in the slots on one side of the bar and another calibration fiber was placed in the other slots. The readings of the dial gauges were taken and the furnace current started. When the reading of the dial holding the standard fiber had changed 0.021 inch, the dial readings were again noted and the change in dial reading of the calibration fiber was divided by the change in dial reading of the standard fiber. This value for the change in dial reading of the standard fiber was chosen because it represented nearly equilibrium temperature conditions for the furnace. This ratio of dial readings $\frac{R_x}{R_s}$, obtained in the manner described above, was then plotted as the ordinate, the known expansion of the glass being the abscissa. Six calibrating fibers were used, ranging in expansion from 6 to 110 x 10^{-7}. The results of this calibration gave a straight line as shown in Figure 7. (*Turn to page* 332)

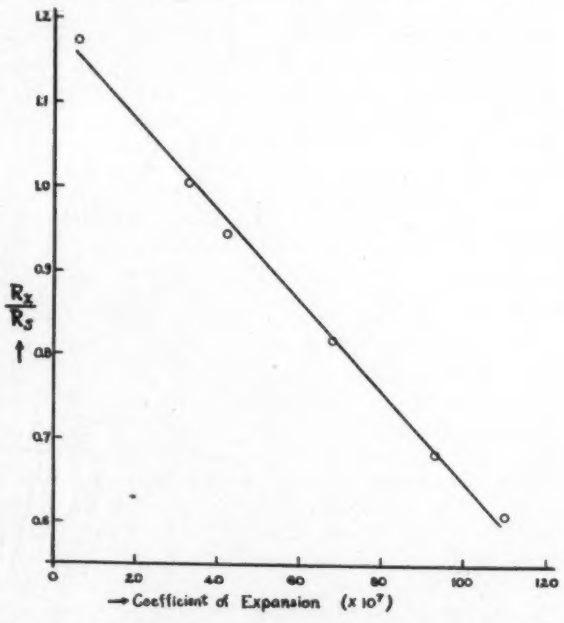


Fig. 7. Calibration curve of expansion apparatus. The ratio of the readings of dial gauges (test glass ÷ standard glass) is plotted against the coefficient of expansion. Points show data for calibrating glasses, the coefficients of which had been previously determined by an interferometer method.

THE WAR AND THE GLASS INDUSTRY

The collapse of France, the present supremacy of the totalitarian states on the European continent, and the armament program to which the United States has become committed, have created a new situation for American industry. Superficially, the new order bears a resemblance to the days of 1917, when the United States was busy, on the one hand creating a military establishment, and on the other, supplying the world with products which European factories could no longer make. World War I brought a substantial increase in business to the glass industry. Will history repeat itself in the months to come?

Of course, a general increase in the tempo of American life, with increased employment and expanding payrolls, should create a general resurgence of life in all business, in which glass would participate. That is to say, if one is content merely to drift, the tide will carry him along. A more aggressive attitude, however, seeks to know if there be any special elements in the situation which could be turned to the special advantage of glass. It would seem that we must look for these (1) in armaments and in the armament industries, and (2) in world commerce; that is, in the replacement of European merchandise at home and abroad.

Fibre glass seems to have the most spectacular, though less obvious possibilities, and particularly in the field of insulation. The two most widely accepted insulating materials are cork and asbestos. Cork comes mostly from the Mediterranean countries; asbestos, from Canada, Russia and South Africa. The supply from any of these sources may become limited, if not non-existant. Not only will the supply become limited, but defense requirements will increase consumption abnormally. Battleships require tremendous amounts of insulating materials; tanks need thermal and acoustical insulation; the extensive use of flame throwers in modern warfare gives rise to a corresponding need to protect men and equipment. For all such purposes, fibre glass has shown itself equal, if not superior to either cork or asbestos.

World War I found the United States ill prepared to produce *optical glass*. However, even though Germany all along has been supplying about half of our requirements, we already have facilities that will produce the best optical glass in quantities far greater than any probable need. As a matter of fact, the tonnage of glass required for optical instruments—bomb sights, range finders, periscopes, binoculars, etc., is not so great as is popularly believed; the high dollar value the glass acquires after fabrication no doubt is responsible for this erroneous conclusion. There does exist a serious shortage of skilled artisans to cut, grind, polish and fabricate the glass into finished optical pieces; but that work is not done by the glass industry.

Manufacturers of *window glass* and *plate glass* do not seem to anticipate any appreciable benefits from a defense program. They would suffer from any curtailment of automobile production, and this to an extent that might easily offset possible gains, as from military housing. Foreign trade does not offer many possibilities. South America is not a large user of plate and it has been expanding its own window glass production. The window glass industry, however, is reported to fear a possible labor shortage and is maintaining inventories against that eventuality.

Manufacturers of incandescent *lamp bulbs* probably will be called upon to supply most of the foreign markets which formerly obtained their requirements from the Netherlands, France, the United Kingdom and Germany. In 1937, exports from these countries were valued at over $12,000,000. The new Christmas tree ornament industry, an offshoot of lamp bulb production, probably will be called upon to supply complete domestic requirements this Fall.

The *glass container* industry should benefit appreciably from any expansion of consumer purchasing power, and moderately from any direct connection with the war. Exports should increase, and this in spite of possible licensing restrictions. During the first four months of 1940, exports equalled about 9 per cent of domestic production, which compares with a normal average of about 2 per cent.

Another possibility is the substitution of glass for tin containers, which would become a likelihood if the war is protracted and should extend to the tin-producing areas. It will be remembered that in 1917 the Department of Commerce issued a pamphlet entitled "Substitutes for Tin Cans," which stated: "It is imperative that the available supply of tin be utilized in so far as possible for packing products that can be preserved only in tin, and that substitutes be used for other products wherever practicable." Today, the need for tin substitutes is not considered as serious as in 1917, at least at the present time. Bolivia has become a tin-producing country, and it is reported that our own tin stocks are considerable.

The war in Europe has provided the *hand made glassware* industry with an opportunity it has long desired, to sell more glassware in the home market. Imports are declining and, barring any increase from Japan, foreign competition will likely remain at very low levels for some time to come. A new spirit seems to have arisen in this branch of the glass industry which manifested itself at a meeting held in Pittsburgh June 10. Here, important executives of the leading companies met to discuss their marketing problem. Highly significant were the remarks of H. B. McCoy, chief of the Specialties Division of the Department of Commerce, who said: "You should not be content with the additional business that may come to you through temporary default by former competition. Sales efforts should be increased. You are still competing with manufacturers of other consumer goods for the consumer dollar. Buyers have criticized American glassware manufacturers for being either unable or unwilling to supply a wide variety of patterns in desired quantities. Every effort should be made to meet reasonable requirements of commercial buyers." Mr. McCoy then went on to recommend a promotional campaign, an important element of which would be a market research. Mr. McCoy's recommendations are receiving serious consideration, and it seems not improbable that the hand made industry is facing new and brighter horizons.

OIL FIRING TECHNIQUE AS PERFECTED BY ANCHOR-HOCKING

At Salem, N. J., the Anchor-Hocking Glass Corp. utilizes oil fuel for all heating purposes except annealing and has perfected a combination of method and equipment that produces excellent results.

In the big container plant of the Anchor-Hocking Glass Corp. at Salem, N. J., the four melting tanks are of the end-port regenerative design and are considerably larger in melting capacity than most furnaces of this type. These tanks were originally designed by the Forter-Teichmann Co. of Pittsburgh, having a melting capacity of about 100 tons per day, each, and have proved exceptionally economical in the matter of fuel cost per ton of glass produced. The fuel is oil and is introduced by a pair of special burners beneath each of the two ports, the burners firing directly into the furnace through the burner blocks. Batch is fed to the furnace through a single doghouse at the side, the feeding being accomplished by Jeffrey-Traylor feeders of the electrical vibrating type. The forehearths of the glass feeders which serve the forming machines at the front of the tanks are also heated by oil, but the annealing lehrs in this plant are heated by electricity.

Even in the Anchor-Hocking organization where low melting costs are nothing new, the Salem plant has made some notable records. In the matter of technique the oil burning methods and equipment have been developed over a period of years and perfected in the light of considerable actual experience with this type of fuel. Another factor in the low fuel costs achieved at this plant is its proximity to a satisfactory source of supply. Most of the fuel oil for the Salem plant now comes from Marcus Hook and is transported by barge down the Delaware river and up a small creek to an unloading dock immediately adjacent to the rear of the plant. When navigation is closed in winter the oil is delivered in tank cars, at an increased cost for transportation of about 58 cents per barrel.

Two grades of fuel oil are used, one for the melting tanks and another for the feeder forehearths. The melting tank fuel is the well-known heavy Bunker-C variety and No. 7 Gas Oil is used for the feeders. From barge or tank car the oils are pumped directly to the storage tanks in the factory yard, these tanks being shown in Fig. 1. The tank for the heavy oil is in the background in this view and has a capacity of 227,000 gallons. There are three tanks for the lighter oil, with capacities of 23,000, 52,000 and 63,000 gallons, respectively.

Under ordinary conditions the oil flows from the storage tanks to the pump room by gravity. The light oil presents no difficulty at any season, but special means are necessary to get the heavy, viscous furnace oil to the high-pressure pumps in cold weather. This is done by means of a steam heating coil at the tank outlet and an auxiliary duplex booster pump which delivers the oil to the main pump suction line.

For the heavy furnace oil there are two high-pressure,

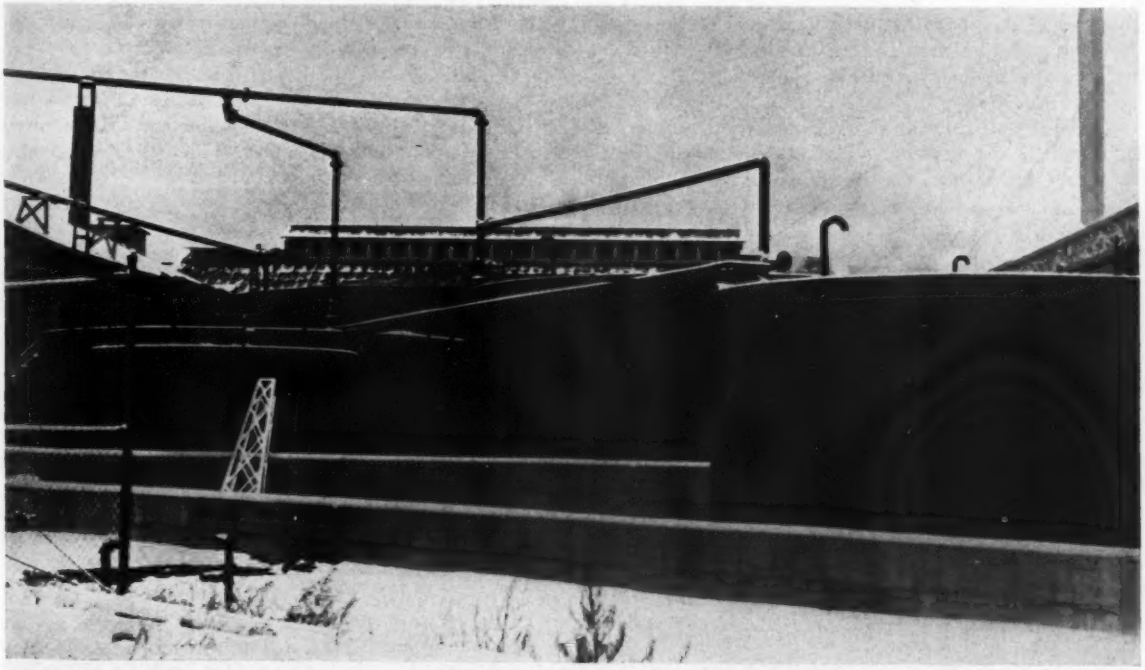


Fig. 1. This view in the yard of the Anchor-Hocking Glass Corp. plant in Salem, N. J., shows the storage tanks in which heavy and light grades of fuel oil are stored. The piping leads from the barge and tank-car unloading dock.

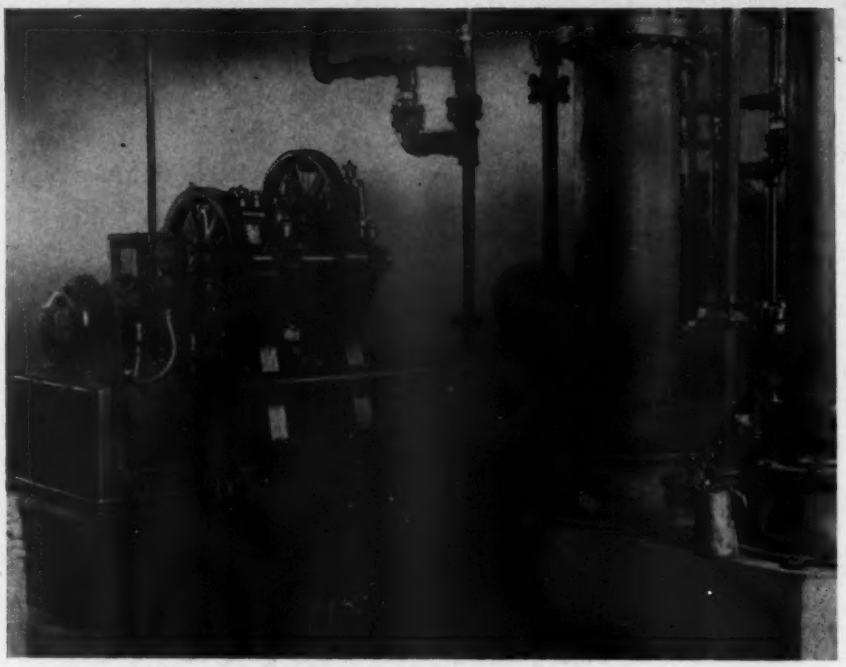


Fig. 2. In the pump room a motor-driven triplex pump receives heavy oil from storage and delivers it to the furnace fuel line at a pressure of 300 lb. per sq. in. Relief valves in the discharge line by-pass excess oil back to storage.

motor-driven, triplex pumps, one of which carries the load while the other is held in reserve. One of these pumps appears in Fig. 2, together with the Lalor fuel oil equipment which heats the incoming oil and provides the proper relief valves and by-passes. Each of the motor-driven pumps has a capacity of 1000 gallons per hour and delivers the fuel at a pressure of 300 lb. per sq. in. The pump operates continuously against the plant fuel line pressure, any increase in line pressure above 300 lb. per sq. in. brought about by reduced firing needs causing the relief valves to open and by-pass part of the pump discharge back to the storage tank. The piping for the pump discharge and in the plant line to the furnaces is of extra-heavy steel pipe connected by ammonia-type fittings.

The heavy oil entering the high-pressure pump is held at a temperature of 100 deg. F. and the pump discharges into another heater. This heater is of the double-pipe, steam-jacketed type and connected throughout by ammonia-type fittings. Pressure gauges are mounted on a pipework frame in front of the heater. The oil is held at a temperature of 180 deg. F. as it leaves the heater and enters the plant fuel line to the furnaces.

The pumping of the lighter oil presents no such problems, either in the matter of pressure or temperature. The two pumps, one of which is a standby, are of the duplex steam type, but are driven by compressed air from the factory line. The oil flows to the pump suction by gravity and is delivered to a 600-gallon pressure tank, pumps and tank being shown in Fig. 3. Part of the tank volume is occupied by compressed air under the factory pressure of 40 lb. per sq. in. and a float valve in a cylinder adjacent to the tank automatically controls the operation of the pump by throttling the air supply to the pump cylinder. This combination of equipment automatically provides a supply of the lighter oil at a pressure of 40 lb. per sq. in. in the line leading to the feeder forehearth burners.

Fig. 3. Air-driven duplex pump discharges lighter fuel oil for forehearth firing to a pressure tank. Float valve in the vertical cylinder at the side of the tank automatically controls the operation of the pump.

The line carrying the heavy oil from the heater to the furnaces is double and is constructed of 2-in. extra-heavy pipe with ammonia fittings. Throughout its length a steam line is located between the oil pipes to keep the oil warm and easily flowing all the way to the burners, all three pipes being heavily lagged with insulation to reduce the heat losses. At each tank a Bailey meter measures the amount of oil used, the meter being housed in a panel with a Bailey fuel-air ratio recorder. Fig. 4 is a view of the control equipment at one of the furnaces, the meter panel standing at the left with the regenerator wall in the background. The stairway at the right leads to the passageway beneath the port necks, in which the burners are located. The opening into this passageway may be seen at the extreme upper right corner of the picture.

The oil piping to the burners and the four control valves are attached to the regenerator steelwork within easy reach of the operator. Each valve controls the flow of fuel oil to one burner and a small pressure gauge just beyond the valve provides a quick, clear indication of whether the valve is open or closed. The upper pair of valves controls the burners beneath one port and the lower pair regulates those under the other port. At reversal time the operator simply closes one pair of valves, reverses the air, and then opens the second pair. It will be noted that the oil is carried at high pressure right up to the burners and that ammonia fittings are used even on the small piping to the burners.

In Fig. 5, which is a view taken in the passage beneath the port necks and looking at the back of the melting end of the furnace, three of the special burners used for tank firing can be seen, together with one of the burner-block openings in front of the nearest burner nozzle. These burners represent the culmination of several years of development work by engineers and operators of the plant, and are now giving excellent, trouble-free service. They utilize compressed air at the factory pressure, as well as low-pressure fan air.

Inspection of the records at the Salem plant shows that, with all four tanks running, the consumption of heavy fuel oil in the melting-tank burners averages from 18,000 to 20,000 gallons per 24 hours. The oil used in the boiler room to produce steam for heating the oil must also be charged into the total fuel consumption. This boiler fuel requirement varies with the season, of course, but a fair average is about 2,000 gallons per day, part of which goes for building heating during the winter. Based on maximum melting capacity, the fuel per ton of glass melted runs regularly between 45 and 50 gallons. Under optimum conditions of loading and weather some of the tanks have been operated for considerable periods at around 40 gallons per ton, but at other times, with low melting loads and severe weather conditions, the fuel consumption may be increased as much as 30 per cent over the averages.

No one factor in the methods and equipment for oil firing employed by Anchor-Hocking at Salem can be credited for the excellent results obtained. While the special design of burners is, of course, of primary importance, such other elements as oil temperature and pressure, careful metering, fuel-air ratio control, furnace design and construction, compressed air utilization, and proper maintenance of all equipment must also be taken into account.

Fig. 4. This view alongside the regenerator of one of the melting tanks shows the Bailey meter panel and the fuel control valves for the four burners. Entrance to the passage in which the burners are located appears at the upper right corner.

Fig 5. The special burners shown here fire into the melting end of the tank through burner blocks located below the ports. Three of the four burners can be seen in this view.

GLASS: ARTIST, DESIGNER, ARTISAN

By ALEXANDER SILVERMAN[1]

Head. Department of Chemistry, University of Pittsburgh

On January 10, 1940, Steuben Glass, Inc., opened an exhibition of twenty-seven engravings on crystal from designs by "renowned contemporary artists." Each of the distinguished painters and sculptors was commissioned by Steuben to prepare a design for the decoration of crystal. It was the purpose of Steuben to perpetuate in glass the character of each artist, and he was given complete freedom of subject. Steuben engravers subsequently tried to subordinate everything except their skill to interpret the work of these artists. The realization required three years. Six copies of each creation were produced. The original was for permanent preservation in the Steuben museum and the other five were for sale at prices ranging from $400 to $1000 each.

In a preface to an illustrated catalogue which was published by Steuben, Frank Jewett Mather, Jr., Director and Curator of the Museum of Historic Art in Princeton University, began, "A work of art may be thought of as a form which has found a fit material or as a material which has found a fit form. Thus a Michelangelo conceives the statue as pre-existing in the marble." Later Mather comments, "From contributors so variously disposed one would expect discordant results. One finds on the contrary a surprising harmony. . . . Now this unexpected harmony is largely due to the pressure of the material upon the artistic form, and here limiting conditions were wisely imposed. All pieces were to be blown. This excluded elaborate shapes in favor of shapes broadly globular, cylindrical or conical. Next, such facile methods as enameling and etching were barred. Everything has to be cut in the glass, itself. The cutting could vary from a mere scratch . . . to deep intaglio. Most of the contributors have chosen this latter technique as traditional and richer."

After commenting variously on the artists, Mather continues, "It seems to me that Manship of all the contributors has most fully realized that he was dealing with a new problem and must find a new idiom in order to solve it, and while I by no means deprecate other more conventional methods, I am ready to guess that the historian of intaglio design in transparent glass is likely to award pioneer honors to Mr. Manship." Speaking of the collection as a whole, Mather states, "In general, while there are a few bad lapses which the spectator must find for himself, from glass idiom the general excellence of the work is gratifying, indeed surprising, since the distinguished contributors are after all novices as designers for glass."[2] Mather then compliments the "extraordinary craftsmen who can cut glass so that twenty different styles may easily be distinguished" and feels that they should be encouraged to sign with the artists. He concludes his preface with the happy thought, "It (this experiment) is symptomatic of much that is going on to make America as good to look at as it is good to live in."

In the same bulletin commenting on the nature of the collection, John M. Gates, Director of Steuben Glass, accounts for the thought which prompted the experiment. Three years before he had met Henri Matisse in Paris. He had with him several photographs of large engraved pieces which were being shown at the Paris Exposition. He found that Matisse was keenly interested and later he took one of the specimens to the artist. Matisse told

Fig. 1. Benton, Diameter 13⅛″

[1]Contribution No. 397 from the Department of Chemistry, University of Pittsburgh. Presented before the Art Divisio nof the American Ceramic Society in Toronto, Ontario, Canada, April 10, 1940.

[2]Mather seems to have overlooked the fact that Sidney Waugh had previously designed for glass.

Fig. 2. Berard, Diameter 13″

Gates that he would like to make a design for Steuben to be engraved in crystal. Gates states, "Greatly encouraged by Matisse's interest, and confident that crystal could be the medium of high artistic expression, I then set about with Steuben's liberal and whole-hearted backing to gather the greatest contemporary artists in Europe and in America into a single group for the purpose of proving that conviction."

In an article in the New York *Times*, February 11, Ruth Green Harris, discussing the collection, writes, "I believe we are on the springboard of a renaissance in the art of glass. The sensitive antennae of an artist, the research of a scientist, the skill of a craftsman, all in close collaboration, will fel a need almost before it is expressed; will discover the most practical combination of glassmaking elements and the way perfectly to fashion them that unimaginable heights of use and beauty may be achieved." After elaboration on this idea, she admits, "To my mind, many of these pieces fail to do so, for two reasons. Some of the designs bear little integral relation to the shape of the object on which they are etched in intaglio; and some are etched in a way that destroys and grays the very nature of the material itself. The fault, primarily, is faulty balance. Instead of thinking in terms of a balance of medium, design and skill, craftsmen, with miraculous aptitude, have in some instances allowed their skill to overweigh, to outstrip, their sense of taste. Skill, then, becomes a sort of frozen slave. It ceases to be malleable. Therefore, the simplest designs in the exhibition, those in which skill has not been overtaxed, are the best." It is interesting to note that the only illustration which accompanies this review is the vase designed by Marie Laurencin, one of only two women among the artists, but she has deservedly won recognition by the woman reviewer.

And now for the author's own comments. Steuben has been noted for precious contributions in all colors and types of artistic production as well as for engravings. It is regrettable that in this instance a group of world famous artists should have been restricted to engraving on crystal instead of being allowed free play as to color of medium and mode of decoration. As a test of flexibility, compulsory design for engraving may indicate how elastic is the mind of the artist, but the question arises, "Does it bring out the best that is in him?" Have some of these great painters and sculptors been cramped when they might have been afforded inspiration though applying themselves to the vitreous, which after all has endless flexibility?

To illustrate the point, let us review the artists in alphabetical order and consider their *unchristened children* in crystal. What were the artists' thoughts? What are they portraying? Is it left to our imagination or is it just a portion of an unfinished symphony in glass which they have merely begun? In any event, only one of the twenty-seven children was named.

This reviewer has had almost forty years of experience with practically every type of glass. Visualizing what might be possible with greater flexibility, remarks which might sound sarcastic or cutting, normally, should be interpreted as constructive with the view further to encourage the representation of varied art in glass.

THOMAS HART BENTON (Fig. 1), whose engraving is on a thirteen-inch plate of his own selection would have been more impressive had his design been pressed, and perhaps on a delicate green rather than crystal.

Fig. 3. Bone, Height 11½"

CHRISTIAN BERARD'S (Fig. 2) design would make a charming etched coaster instead of a thirteen inch plate, which he selected.

SIR MUIRHEAD BONE (Fig. 3) has created a charming group for casting in alabaster Patte du Verre. He selected the blank from one of five drawings submitted to him.

JEAN COCTEAU (Fig. 4) could become a second de Corchemont were his heads sculptured in massive crude greenish crystal. He did not specify the blank on which it was to appear.

JOHN STEUART CURRY (Fig. 5) has created a design which looks like a world's fair shield for Kansas on the roundal which he selected. Imagine it in colored

Fig. 4. Cocteau, Height 11¼"

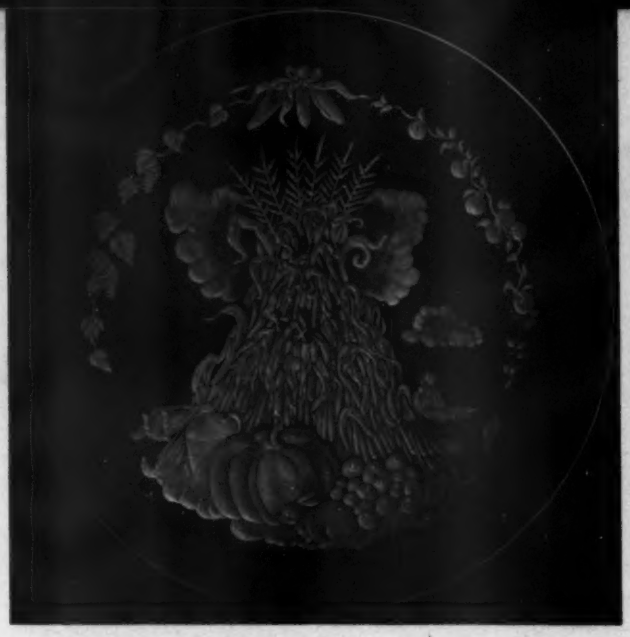


Fig. 5. Curry, Diameter 14"

Fig. 6. Dali, Height 8¾"

Fig. 7. De Chirico, Height 11¾"

Fig. 8. Derain, Height 11¼"

enamel on an opalescent background. The appeal would be entirely different.

Salvador Dali (Fig. 6) is puzzling. His subject was evidently floored after throwing out her chest too far and is beyond the author's vitreous interpretation. Dali apportioned his design to the stock blank which he selected.

Giorgio De Chirico (Fig. 7) is true to his origin. The portrayal of Greek art belongs on a tall urn, but should it have had that heavy base?

Andre Derain (Fig. 8) was the son of a successful pastry cook. The doughy looking design on his vase never belonged on crystal. It would attract in dense opal of a creamy white hue or perhaps a touch of flesh pink or even ecru. Derain did not select the blank.

Fig. 9. Dufy, Height 11⅝"

Fig. 10. Gill, Height 14"

RAOUL DUFY'S (Fig. 9) interest in carpets and tapestries is in evidence in his design for crystal. This creation engraved on a fabric-like surface instead of a plain polished one could have been much more attractive. It might also have looked good in white enamel or as an engraving on pale cobalt blue crystal. However, Dufy did not select the blank.

ARTHUR ERIC ROWTON GILL'S (Fig. 10) pair of tall vases portrays the monastic simplicity in which he lives. They afford a good example of ancient pattern. On a plain base they might be superb. Why did the designer attach the conventional foot of other Steuben products?

DUNCAN JAMES CORROWR GRANT (Fig. 11) has weighed down his figure and the designer who proposed the blank has ingeniously made it impossible

Fig. 11. Grant, Height 11½"

for the figure to straighten up. The interpretation of the design by the artisan is perfect, and the blank is admirably suited. One would almost suspect that it had sagged during annealing.

JOHN GREGORY (Fig. 12) has visualized his medium. Just as his nine panels in marble on the exterior of the Folger Shakespearean Library in Washington, D. C., afford a superb example of relief sculpture on marble, his first two figures on glass should serve as an invitation for further contributions in this field. His design of the blank is excellent.

JEAN HUGO (Fig. 13) realizes the limpidity of his new medium; his designs also prompt encouragement. Those handles are a bit heavy, but the artist and bowl proper are in harmony. The blank was chosen by a designer.

PETER HURD'S (Fig. 14) pastoral belongs anywhere

Fig. 12. Gregory, Height 15⅛"

Fig. 13. Hugo, Height 8¾"

Fig. 14. Hurd, Height 12⅜"

Fig. 15. Kisling, Height 19⅝"

Fig. 16. Kroll, Height 18⅝"

except on crystal. It would afford a beautiful relief on a dense opal plaque of the proper shape. He was not responsible for the choice of blank.

In MOISE KISLING (Fig. 15) we have evidence again of promising design for the crystal medium. His first contribution reminds one of Simon Gate, except that the artisan might have used a more appropriate base for the blank.

LEON KROLL (Fig. 16) is the victim of a blank which was not of his own choosing. Why were the mother and child bottled up, when they should be rising to open heights?

MARIE LAURENCIN (Fig. 17) may have been identi-

Fig. 17. Laurencin, Height 11"

Fig. 18. Leger, Height 11".

Fig. 19. Maillol, Height 12".

Fig. 20. Manship, Height 13¾"

Fig. 21. Matisse, Height 14¾"

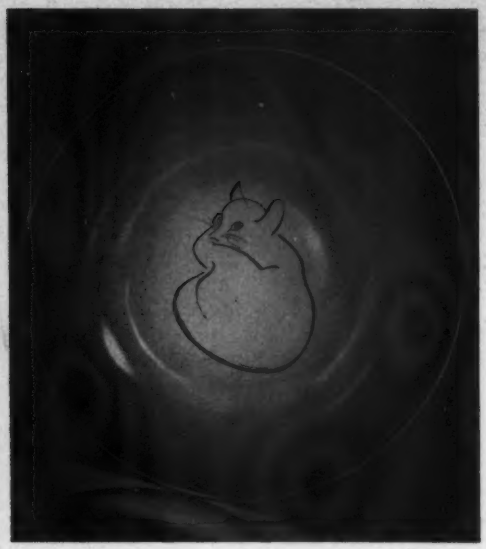


Fig. 22. Noguchi, Diameter 10"

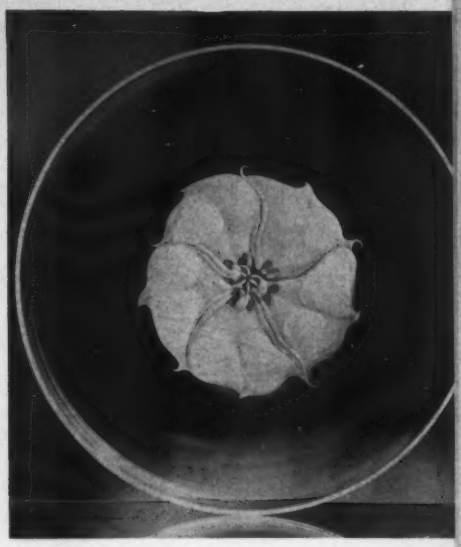


Fig. 23. O'Keeffe, Diameter 14"

fied with the French theater and designed stage decorations and costumes, but she knows how to interpret crystal glass. Her contribution is charming. A light design in contrast to a heavy bowl is better than a design which weighs the object down. She was fortunate in having a suitable blank provided for her design.

FERNAND LEGER (Fig. 18), the mechanic, has on the contrary placed so heavy a charge in his crystal bowl, which was handed to him, that it might have exploded.

ARISTIDE JOSEPH BONAVENTURE MAILLOL (Fig. 19) might almost be suspected of having worked on glass before. He again resembles the Swedish artists and gives real promise in his new medium. The blank was not of his own choosing.

To PAUL MANSHIP (Fig. 20), congratulations for both design of decoration and of host; also, to the artisan for his excellent execution. The bacchanale may not be novel, but the receptacle is the outstanding one of the entire collection.

Not a lover of HENRI MATISSE (Fig. 21), the author is less enamored than ever after what he did to glass. The artisan did exceptionally well in adapting the blank to the design.

ISAMU NOGUCHI'S (Fig. 22) inanimate lines are interesting. His "cat, quite as a cat might, arranges itself superbly within the inside circle of a simple plate" of the artist's choosing, according to Ruth Green Harris. Is this your interpretation, also?

GEORGIA O'KEEFFE (Fig. 23) should provide relief patterns for opalescent glass. Her designs, in this medium, would possess greater charm than the engraving on the plate which she selected.

JOSE MARIA SERT (Fig. 24) belongs on anything but the vase which carries his gymnasts, which a designer selected for him. That group would make a fine Patte du Verre casting in three dimensions.

PAVEL TCHELITCHEW'S (Fig. 25) imagination may not appeal to everyone, but he does know how to ac-

Fig. 24. Sert, Height 13"

Fig. 25. Tchelitchew, Height 13½"

Fig. 26. Waugh, Height 15⅜"

commodate his design to the round bowl which he selected. Perhaps, a foot is necessary on the bowl as well as on the balancer. Is it?

SIDNEY WAUGH (Fig. 26) is an artist born to glass. His contributions have been significant. This is merely another example of his fine designs for crystal media. The shape of the blank, specied by Waugh, is further proof. The title "Archipelago" makes the design more fascinating.

Finally, in GRANT WOOD (Fig. 27) we have what could have been a superb wood carving, but does it belong on crystal? The artist is not responsible for the blank which was chosen.

This review may impress you as the strongest of an art exhibit which you have yet encountered. It is intended as an interpretation of art in terms of the medium in which it must be expressed. Not every artist can design for glass. The designer may have to be a middleman. Not every artisan can interpret the artist. Again, the designer might serve as the intermediary. Glass, from the water clear through the opal to the apaque, and with its possible fifty thousand color tones, should lure the modern artist to new heights. He has expressed himself through mosaics, canvas, clay, marble, bronze, and fabrics. The vitreous plastic invites his further attention.

To Steuben, congratulations for a beginning. That Rome was not built in a day is obvious. That the creations are "monstrosities" as one critic put it, is no more true than to say that the twenty-seven are perfect. Were they in their best medium in crystal? Would they have been better in something else? Was the choice of the blank always a fortunate one? Was every work of art capable of responding to the same type of illumination? Would selective lighting to suit individual needs have been better?

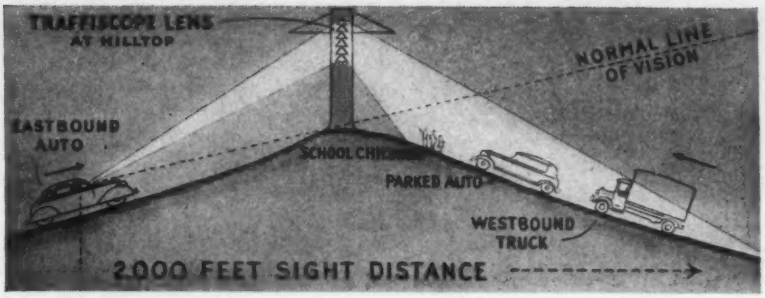
The author understands that all flat plates were indicated by the artists, although the actual profile of the plates was left to the artisan. In two cases artists selected stock pieces as blanks and their designs were made to fit these shapes. In another case five blank drawings were submitted to the artist, who selected one and made his design to fit. In five cases the artists indicated rather precisely the shape of the blank wanted for

Fig. 27. Wood, Height 13½"

their designs. The remaining blanks were designed or chosen by Steuben.

The relative popularity to date of the engraved pieces has been indicated to the author officially with Marie Laurencin unquestionably heading the list. De Chirico and Manship constitute group two. In group three are Kisling, Gill, and Bone. The remaining artists are placed in group 4.

A trail has been blazed in America. A journey has begun. Artist, designer, artisan, and manufacturer have set out on this trail. With mutual sympathy and understanding they can bring America to the fore in the field of art for glass.



How the Traffiscope works. By changing the shape of the prisms, the angle of refraction of the lens can be varied in accordance with the grade so as to give the approaching motorist a minimum sight distance of 2,000 feet.

GLASS MAKES HIGHWAYS SAFER

A new device, the Traffiscope, has made its appearance along highways in many parts of the country. Straddling the road at the top of a rise, the Traffiscope gives the man at the wheel a clear view of what lies over the crest, and tells him whether or not it is safe to pull out of line or if danger lies ahead. The success which the device has encountered to date and the existence of "blind spots" on practically every automobile road of the country suggests this new use for glass should consume tons of this product.

The Traffiscope consists of a steel framework in which is set a composite lense made up of four banks of oblong glass prisms each 40 inches long, 4 inches high and 1½ inches thick at the base. There are seventeen prisms in each bank, mounted one above the other, and they are so proportioned that the lens as a whole gives an unbroken picture of what lies ahead. The construction is flexible so that a lense of any desired width and height and with the necessary angle of refraction can be provided to meet local conditions. For a regular 4-lane highway, the lens unit is about 13′ long x 5′ high.

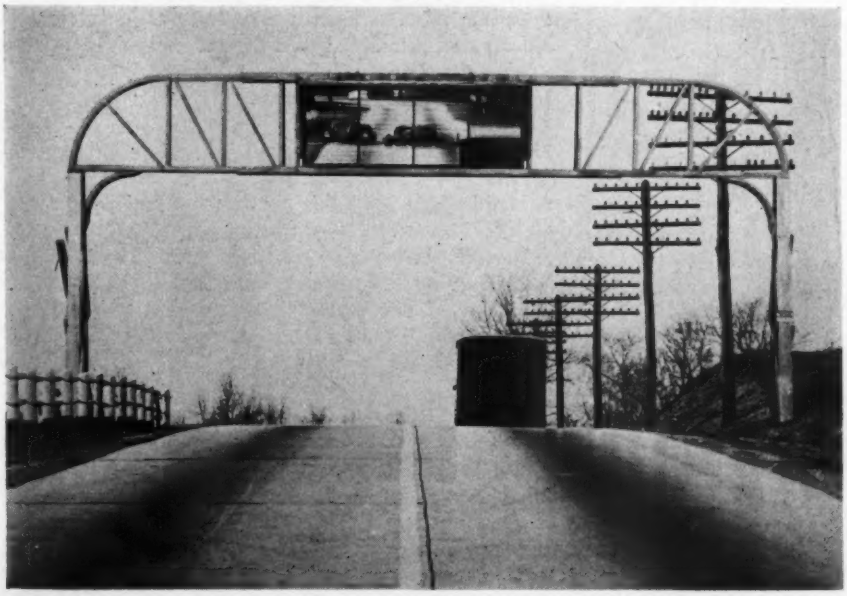
As a motorist approaches the Traffiscope, he sees in the glass lens the stretch of road immediately beyond the summit. He receives a full but flattened view of it which does not interfere with normal judgment of distances, and the image of any object coming toward him moves from the top of the lens to the bottom, where it disappears a few seconds after the actual object reaches the hilltop and comes into sight. The safety tower is said to work equally well at night, as the glare from the headlights is not transmitted by the lens. Hoods that project out far enough to create pockets of dead air protect the lens from obscuring moisture.

Several of the Traffiscopes have been set up in different parts of the country for test purposes. The initial installation was made in April 1937 a few miles south of Minneapolis, Minn., and in the meantime no accidents have occurred at what was formerly a danger spot.

PITTSBURGH PLATE PROMOTIONS

Directors of the Pittsburgh Plate Glass Company have made a series of changes resulting in promotions and rearrangement of executive duties.

Vice president Robert L. Clause was elected to a newly created position of executive vice president. John A. Wilson, general superintendent of plate glass factories, will become manager of glass manufacture; D. G. Hill, assistant to the vice president, will become superintendent of plate glass factories; R. B. Tucker, manager of plate glass sales, will become director of glass sales; B. J. Cassady, secretary of the commercial department, will become general manager of warehouses.



The Traffiscope is a composite lens set in the center of a steel framework. Bridging the highway, it gives a flattened view of what lies beyond. Source: *Compressed Air Magazine*, which courteously supplied both the data and the illustrations on this page.

CURRENT STATISTICAL POSITION OF GLASS

May activity in the glass industry dropped below April's level with production, employment and payrolls experiencing slight dips; exports continued strong as imports declined. According to the Glass Industry's Production Index, output was valued at $29,000,000 as compared to $26,000,000 in last year's comparable month. The January-May cumulative total is placed at over $145,000,000—almost 20 per cent of 1939.

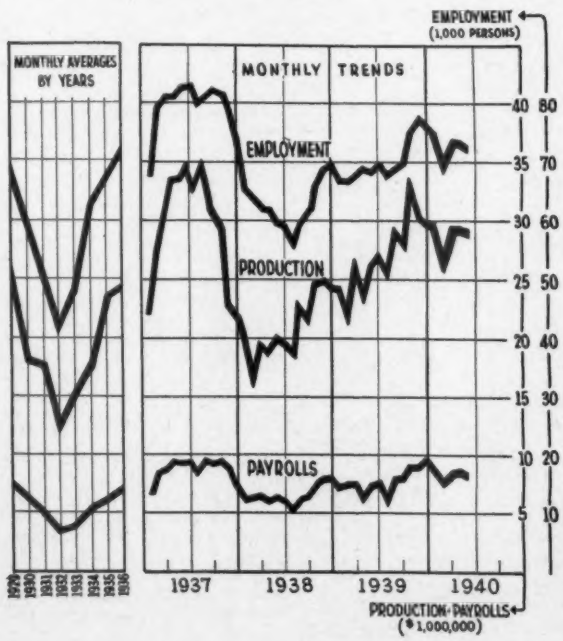
Plate glass production during May totalled 11,720,547 square feet according to the Plate Glass Manufacturers Association. This was a decrease of 5 per cent from last month but was 46 per cent greater than last May's total. Output during the first five months of 1940 amounted to 68,822,000 square feet—an increase of 39 per cent over 1939's comparable figure.

Window glass production during May was reported to be 1,068,231 boxes, or an increase of 4 per cent over April. This was 47 per cent greater than May of last year. During the January-May period, window glass output totalled 5,710,000 boxes as compared to 4,132,000 boxes during the same months last year.

Glass container production during May totalled 4,700,677 gross, according to the Glass Container Association. This represented an increase of 3 per cent over April and 4 per cent over May of last year. Shipments were up 10 per cent over April and 6 per cent over May 1939. For the first time in nine months, stocks on hand declined, relieving to some extent the high inventory condition that has existed during recent months. On May 31st these inventories amounted to 10,077,900 gross which was 2 per cent below the April level but was 22 per cent greater than last year's May figure. A comparison of totals for the first five months of 1940 with 1939's similar period shows that production is up 13 per cent to 22,277,000 gross and shipments 9 per cent to 20,887,000 gross. The industry continues to break its 1937 production record but shipments are slightly below that year's totals.

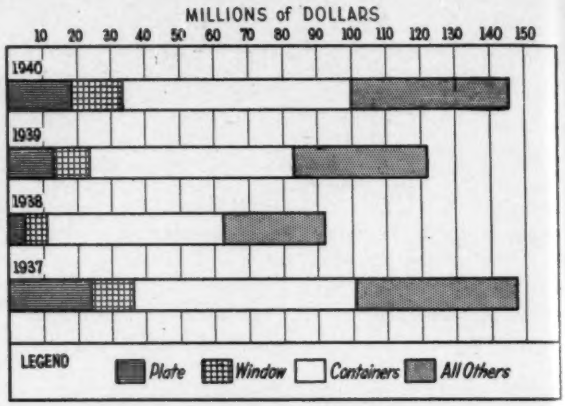
GI THE GLASS INDUSTRY'S INDEX

Monthly Trends Through May, 1940



GI THE GLASS INDUSTRY'S INDEX

Production for Five Months, January Thru May



Miscellaneous glass products manufactured during May were valued at $9,000,000 according to reliable estimates. This was slightly below April's figure, but exceeded May of last year by about $1,000,000. Activity in the illuminating ware branch was 5 per cent under April's level and dropped about 10 per cent behind May of 1939. Manufacturers of handmade tableware continued to report increases over last year's volume. It has been estimated that on a five month basis, operations in the miscellaneous glassware branches were at least 15 per cent ahead of last year.

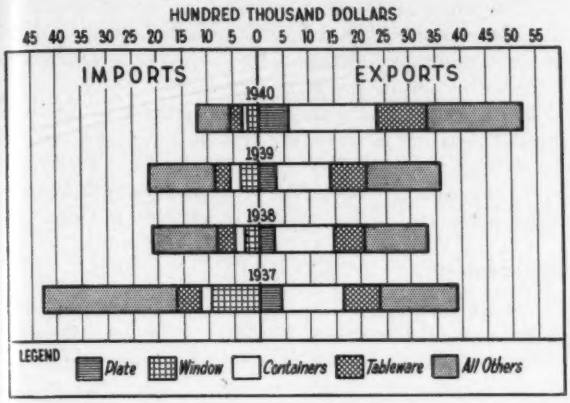
Employment and Payrolls: The glass industry employed 72,600 persons in May as compared to 73,600 in April; in May 1939 this employment was estimated at 68,000.

Payrolls during May totalled $8,100,000—a drop of $300,000 from the previous month, but $1,000,000 greater than May of last year. Glass manufacturers paid out over $41,000,000 to their employees during the first five months of 1940, as compared to less than $36,000,000 last year.

Foreign Trade: Exports of glass during May were valued at $1,169,000—an increase of 18 per cent over April and 39 per cent ahead of May 1939. All types of glass products with the exception of certain container items and illuminating ware shared in the increased trade. Foreign sales of plate glass increased 123 per

THE GLASS INDUSTRY'S INDEX

Foreign Trade for Five Months, January Through May



cent, while window glass shipments were up 100 per cent; on a volume basis, tableware lines showed large increases, with a total net gain of $59,000 over April. During the first five months of 1940 American glass manufacturers shipped ware valued at $5,259,000 to foreign markets; this compares very favorably with last year's comparable figures of $3,584,000. An analysis of these totals reveals increases in all types of glass products running from the 473 per cent jump in window glass sales to the 37 per cent increase in the tableware group.

Imports of glass products during May were valued at $216,000—20 per cent below April's figure and 17 per cent less than May of last year. (In analyzing these figures it should be remembered that they are "imports for consumption," which include warehouse withdrawals. It is believed that a good portion of these May import totals constitute such withdrawals rather than arrivals from abroad.) These statistics indicate that purchases of foreign containers were up 7 per cent over April; other products declined as follows: plate glass—45 per cent, window glass—52 per cent and tableware 29 per cent. During the January-May period our import trade in glass products dropped 43 per cent below last year's figure to $1,253,000. The only exception to this trend was in the plate glass branch—where an increase of 276 per cent was recorded.

G.C.A. PRESENTS AMBULANCE TO BRITISH

As a result of informal talks at the White Sulphur Springs meeting of the Glass Container Association, a check has been sent to the New York office of the British War Relief Society for the purchase of an ambulance to be sent to Great Britain.

Dr. Frank W. Preston, chairman of the Regional Committee for Western Pennsylvania, West Virginia and Ohio with headquarters at 526 Penn Avenue, Pittsburgh, states that not all members of the G.C.A. have been notified, and no glass men outside of the container field have been notified. Since the appeal was issued an SOS has been received from England asking for 250 American ambulances on Ford or Chevrolet chassis. Dr. Preston further states that funds will come in to purchase a second ambulance, or an X-ray machine.

L-O-F BUYS PLASTICS FIRM CONTROL

The Libbey-Owens-Ford Glass Co. has purchased a controlling interest in Plaskon Co., Inc., largest producer of urea plastics in the country from the Toledo Scale Co. The General Aniline and Film Corporation will continue to hold the minority interest. The present management and sales policies will be continued under James L. Rodgers, Jr., president of Plaskon.

Plaskon, which has plants in Toledo and Grasselli, N. J., produces urea-formaldehyde molding compositions used by manufacturers of electrical equipment, lighting shades and reflectors, radio, clock and scale housings, and by the general plastic molding trade.

WILLIAM A. HARSHAW

William Andrew Harshaw, chairman of the board of the Harshaw Chemical Company, Cleveland, died June 4 at his estate in Gates Mills after a prolonged illness. He was seventy-eight years of age.

UNITED STATES FOREIGN TRADE IN GLASS
(Value in Thousands of Dollars)

	1940			1939		Percentage of Changes		
	May	April	First five months	May	First five months	April-May	May-May	Five months
EXPORTS								
Plate	132	59	557	83	361	+123	+ 59	+ 54
Window	24	12	86	2	15	+100	+1100	+473
Containers	348	350	1763	284	1155	— 1	+ 23	+ 53
Tableware	247	188	945	172	689	+ 31	+ 44	+ 37
Illuminating Ware	58	62	278	35	174	— 6	+ 66	+ 60
All Other	360	323	1630	267	1190	+ 11	+ 35	+ 37
Total	1169	994	5259	843	3584	+ 18	+ 39	+ 47
IMPORTS								
Plate	16	28	98	5	26	— 43	+ 220	+276
Window	24	60	204	50	373	— 52	— 52	— 45
Containers	16	15	75	16	177	+ 7	....	— 58
Tableware	41	58	286	48	350	— 29	— 15	— 18
Illuminating Ware	8	8	35	10	239	...	— 20	— 85
All Other	111	101	555	132	1020	+ 9	— 16	— 46
Total	216	270	1253	261	2185	— 20	— 17	— 43

INVENTIONS AND INVENTORS

Summary of United States Patents of Interest to the Glass Industry, Issued During May

Compositions

Two patents granted for glass compositions for metal vapor discharge lamps were assigned to General Electric Company. The patent to Hermann Krefft of Berlin-Friedrichshagen, and his associates (2,200,958), is confined to the composition shown in column 1 below. Somewhat broader claims for compositions of another type were granted to John H. Partridge, Middlesex County, England, in patent 2,199,856. The range of the Partridge compositions is shown below. He states that these compositions have unusually high softening points for this type of glass (up to 1080 deg. C.) and yet are capable of being founded at 1600 deg. C.

	Krefft	*Partridge Example*	*Partridge Maximum Range*
SiO_2	50%	60%	60-70%
Al_2O_3	25%	28%	25-35%
CaO	6%	8%	6-11%
MgO	8%	—	(+1 to 6%
BaO	5%	—	from group
P_2O_5	5%	—	MgO, BaO,
B_2O_3	1%	—	ZnO, ThO_2)
ThO_2 (Thoria)	—	4%	

Wm. J. Harshaw and Wm. D. Stillwell of South Euclid, Ohio, assigned two patents for opacifiers for vitreous enamels to the Harshaw Chemical Company. Patent 2,199,794 covers a pre-calcined mill addition containing CaO, Sb_2O_5, TiO_2 and CaF_2. Patent 2,200,170 provides for firing together an oxide of antimony, a fluorine mineral, an oxide of titanium or zirconium, an oxide of a base-forming metal, and an oxidizing agent, which product is then used as a mill charge with enamel frit.

Feeding, Forming and Shaping

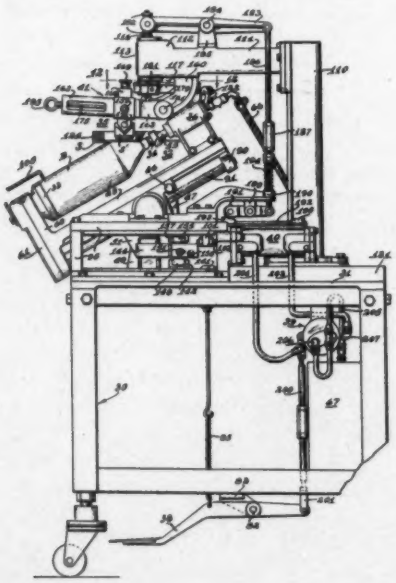
Ball Brothers Company received, through assignment, patent 2,202,409 issued on May 28 to the late Frank L. O. Wadsworth of Pittsburgh. This latest addition to an important group of shearing and feeding patents provides a shear mechanism which moves with the charge, giving it acceleration downward and also in the approximate lateral direction of the mold movement.

In the process of forming glass articles by casting molten glass into a mold, the trouble ordinarily caused by sticking to the mold is overcome, by Roy W. Moore of Schenectady, by coating the mold surfaces with a layer of boron nitride. Patent 2,201,049, assigned to G. E. Co.

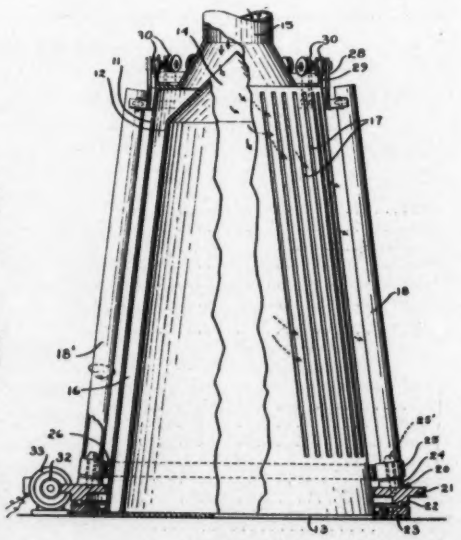
Decoration

The apparatus shown in Fig. 1 was devised by Albert S. Jackson and Clarence A. Heyne of Alton, Ill. (Owens-Illinois, patent 2,202,799) for the semi-automatic stencilling of vitreous enamel decorations onto the tapered shoulders of glass bottles or jars. The bottle is rotated while held by chucks on a tiltable table, so that color can be applied from a squeegee through the screen, S, which reciprocates horizontally.

Corning Glass Works received patents 2,202,326 and 2,202,327 for frosting the inside of lamp bulbs with gaseous hydrogen fluoride. The inventors were Herbert S. Willson and John A. Yunck, respectively. The coating is said to be quite different from that obtained with usual liquid etching solutions containing hydrofluoric acid and fluorides. These prior methods gave numerous microscopic crevices which cause diffusion of transmitted light. The new hydrogen fluoride treatment gives an adhering frost which, however, may be rubbed or wiped off. It can also be removed by a jet of water, leaving the glass surface apparently unchanged. In the method detailed in patent 2,202,326, the hydrogen fluoride is admitted to the bulb after partially exhausting the air. The frosted bulb is afterwards baked at about 400 deg. C. to remove volatile materials. If a small amount of ammonium chloride is volatilized into the bulb during baking, the fluoride coating is partially converted to chlorides.

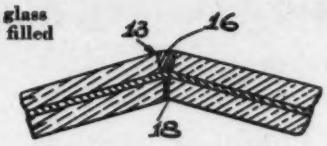


2,202,799: Jackson & Heyne. Stencilling the tapered shoulders of bottles.

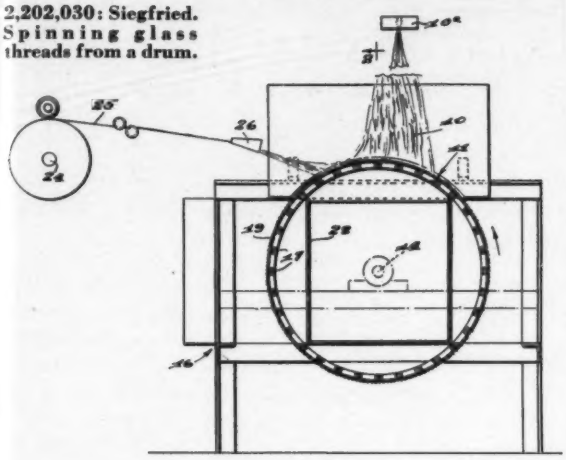


2,202,100: Grant. Device for cooling newly formed glass cylinders.

2,202,690: Fix. Bent glass windshield with bend filled with plastic.



2,202,030: Siegfried. Spinning glass threads from a drum.



Miscellaneous Processes

Fig. 2 illustrates the glass cylinder cooling tower patented by Jesse Grant, Corning, N. Y. (Corning Glass Works, patent 2,202,100). Two concentric metal cones receive air through the stack 15, and direct it against the glass cylinders through vertical slots 17 in the outer metal cone. The glass cylinders (received by the cooling apparatus directly after forming) are revolved about the tower past the slots and are also rotated.

In inspecting filled beverage bottles, drops of water on the outside of the bottle may appear to be foreign materials within the bottle. To prepare such fare for viewing with an optical system, L. T. Sachtleben, Camden, N. J., (Radio Corp. of America, patent 2,200,100) provides an inspection device with means for rapidly whirling the bottle and simultaneously directing a high velocity blast of air against it.

Patent 2,199,807 to Francisco Elias de Godoy Moreira of S. Paulo, Brazil, is a device for cutting glass tubes.

For use in a lehr, Orie Shackleford of Fairmont, West Va., provided a conveyor belt, comprising a wire mesh whose interstices are filled with a plastic heat resisting material having insulating value (patent 2,199,529).

Plate and Sheet Glass

Plastic compositions for laminated glass were patented by Barnard M. Marks, Upper Montclair, N. J., (duPont) and Carleton Ellis, also of Montclair, assignor to Ellis-Foster Co. The Marks patent 2,202,160 provides a sheet of polyvinyl butyral plus polyvinyl acetate up to 2 per cent, and 17.5 to 22.0 per cent polyvinyl alcohol, plasticized by 43 to 51 parts of triethylene glycol dipelargonate. Carleton Ellis' patent 2,200,691 relates to urea resins as made by reacting urea, formaldehyde and phthalic anhydride, and reveals that improved flexibility and adhesion is obtained by using glycerol and glycol as modifying agents.

Composition of the plastic sheet in laminated glass was involved also in patent 2,200,969 granted to Joseph D. Ryan and James D. Gwyn of Toledo (Libbey-Owens-Ford). They utilize a layer comprised of a polyvinyl acetal resin formed by the reaction of a saturated aldehyde on a hydrolyzed polyvinyl ester, with a dialkyl sebacate as a plasticizer.

Pittsburgh Plate Glass Co. was the assignee of Arthur D. Nash's patent 2,202,714 for a means of dressing slabs of cellular glass. This glass, made by the heating of crushed glass with bubble forming materials, such as calcium carbonate, has an objectionably rough surface, when thick blocks are sawed into slabs. Nash dresses the surface with a layer of finely crushed glass and a flux, and then exposes the plate to a temperature sufficient to fuse the dressing layer to the slab. The temperature must not be high enough to deflate the cells.

Another interesting patent obtained by Pittsburgh Plate Glass was Earl L. Fix's patent 2,202,690 for bent safety glass. The primary object is the provision of a one-piece windshield which conforms to modern designs of streamlining. Because of the reported impracticality of constructing an angular windshield from a single flat sheet of flat safety glass, a split construction with view-obscuring central bar has become common practice. The Fix invention as illustrated by Fig. 3, consists of cutting through the two glass layers, without cutting the plastic interlayer, then heating and bending the sheet to the desired angle, and filling the cracks with additional plastic material, 16.

Wm. Owen of Pittsburgh (Pittsburgh Plate Glass Co.), whose patents are numerous and diversified, received another for an apparatus to be used in pressing together curved safety glass (2,202,670). The assembled sheets and plastic layer are heated to soften the resin, and then are pressed between so-called nipper rolls.

Machines for cutting glass sheets were patented by Harmon W. Archer, Fort Smith, Arkansas, (2,202,751) and by Ben F. Anderson, Shreveport, La., (2,200,975 to Libbey-Owens-Ford Glass Co.). The latter company was assignee also of John L. Drake's patent 2,200,984 for an apparatus for grinding the curved edges of glass sheets.

Patent 2,199,511 for a process and apparatus for tempering glass sheets was granted to Harold Perry and Augustus W. Grotefeld, Stafford, England, (Gilt Edge Safety Glass, Ltd.). The heated sheets hanging vertically, are cooled on both sides simultaneously by water from spray units, elongated vertically; sheets and spray units are both moved horizontally.

In patent 2,201,286 assigned by Albert J. Bundy of Jeannette, Pa., to the American Window Glass Co., it is reported that the waves in drawn glass sheet are influenced by the nature of air movement in the drawing chamber. The patent covers means of substantially eliminating such waves by providing for transverse rather than vertical or eddy-like movement of gases across both sides of the sheet, at the meniscus and above it.

Another patent assigned to American Window Glass Co., was 2,200,354 granted to Frederic L. Bishop, Jr., of Jeannette, for a cleaning fluid to be used on laminated glass. The fluid is made by heating an ether of the group consisting of dichloroethyl ether and the chlor-ethoxy-chlor-ethyl ether together with a metal of the group consisting of ferrous metals, tin and aluminum to approximately the boiling point, for about three hours.

(*Continued on page* 331)

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	46.00	43.00
Reduction on precipitated material, $5.00 a ton			
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.0215	.027-.0295
Powdered	In bags, lb.	.024	.0295-.032
Boric acid (H_3BO_3) granulated	In bags, lb.	.048	.054-.0565
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite (Na_3AlF_6) Natural Greenland (Kryolith)	lb.	.0865-.0875	.0925
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	30.00-31.00	....
In bags	ton	31.60-32.60	42.00-45.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.075	....
In 5 Ton lots	lb.	....	.08
Less than 5 Tons	lb.	....	.085
Lime—			
Hydrated ($Ca(OH)_2$-MgO) (in paper sacks)	ton	8.50	8.50
Burnt (CaO-MgO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	9.00
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$-$MgCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$-$MgCO_3$) 16x120 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	12.50	14.50
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	18.00-20.00	25.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	Per 100 lb.	....	2.50-2.90
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.415	1.44
100 lb. bags		1.45	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.026-.029	.03½
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Antimony oxide (Sb_2O_3)	lb.	.14	.14½
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03¼	.03¾
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite, (20% Al_2O_3)	ton	9.00	12.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.08-.08¼	.08½-.09
Tin Oxide (SnO_2) in bbls.	lb.	....	.54
Titanium Oxide (ceramic grade)			
In bags	lb.	.12	.12¼-.12¾
In barrels	lb.	.12¼	.12½-.13
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¼	.06½
White Seal, 150 lb. bbls.	lb.	.08¼	.09
Green Seal bags	lb.	.08	.08¼
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled .01-.02c higher)		.06½	.07-.08

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40-1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.00-1.05
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.22-.25
Chromite (99% through 200 mesh)	ton	40.00	44.50
Chromite ore (air floated)	ton	55.00	58.00-73.00
Cobalt oxide (Co_2O_3)			
In bbls. 350 lbs. or more,	lb.	....	1.84
Less than 350 lbs.,	lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.165
Black (CuO)	lb.	....	.18-.19
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.05-.09½
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$) in bbls.	lb.	....	.135
Manganese, Black Oxide			
In Paper bags	ton	62.50	70.50
In Burlap bags	ton	64.25	72.25
In Casks	ton	66.50	74.50
Neodymium oxalate, 50 lb. drums	lb.	....	3.50
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	.08¾	.09-.09¼
Powdered	lb.	....	.09¼-.09¾
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.19-.24
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07-.07¼
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08¼	.08¾-.08½
Sodium selenite (Na_2SeO_3)	lb.	....	1.50-1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.75-1.85
Yellow	lb.	....	1.75-1.85
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.65-2.75
Yellow orange	lb.	....	1.75-1.85

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	.063	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1.	lb.	....	.04
Putty Powder	lb.	Open price.	
Rotten Stone, (Domestic)	lb.	....	.03½
Rouge, Red	lb.	....	.16
Black	lb.	....	.18

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EQUIPMENT AND SUPPLIES

PRATER ANNOUNCES NEW BATCH MIXER

A large scale adaptation of the scientific principle of mixing by the method of cut-divide-remix is contained in the design of the Prater Horizontal Mixer. This machine is announced by the Prater Pulverizer Company, 1876 South 55th Avenue, Chicago. Rated at one ton capacity, of the horizontal drum type, the mixer presents a new combination of mixing and lifting blades and dual spirals running in opposite directions within the drum.

The course of the material in the mixing cycle is interrupted and changed 26 times per minute. The mixing and lifting baffles are offset, so that they alternately collect their loads from the opposite ends of the drum and feed them evenly back to the dual spirals. These spirals revolving in opposite directions again divide the load and each spiral carries its portion to the opposite end of the drum. With six baffles and two spirals operating in a drum revolving 4½ times per minute, the mathematical calculations of the degree of mix rapidly reach completeness.

Another unique feature of the mixer is the thorough seal at both ends of the drum by special double seals held in spring tension so that regardless of the fineness of the material none will escape.

CATALOGS RECEIVED

A. P. Green Fire Brick Co., Mexico, Mo., has issued a folder describing their S.M. and D.P. Empire High Heat Duty Fire Brick for long, low cost service and freedom from repairs and shutdowns.

Corning Glass Works, Corning, N. Y., an improved type Flowmeter of Pyrex which is self-contained and requires no extra parts. Also, a Manometer which is available in two types, "T" arm and straight side arm.

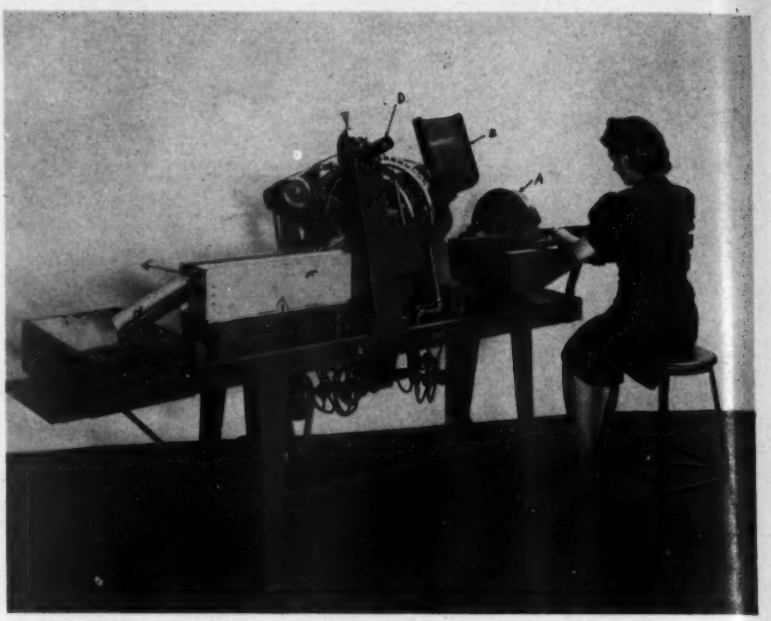
Chicago Belting Company, Chicago. A new condensed 24 page catalog, describing and illustrating numerous types of "Tension Welded" leather belts. The "Tension Welded" process of manufacturing leather belts is described along with technical and installation data. The various products of the company are also described in the catalog. A new catalog is issued about every eight years.

DESERT CHEMICAL BUILDS

The Desert Chemical Company of 4031 Goodwin Avenue, Los Angeles, California, is constructing a large plant at Dale Lake, California, for the production of anhydrous sodium sulphate.

Construction of the plant was started late last year and is now being completed. The installation includes a power plant, housing accommodations, pipe lines and vats. Forty-four test wells drilled on 500 acres of the property indicates more than 13,000,000 tons of sodium sulphate are in that area. Other test wells over the balance of the property estimate that between twenty and thirty million tons are available.

It is reported that the analyses of the sodium sulphate is uniformly 99.5 per cent pure or higher, with less than five-hundredths of one per cent insoluble. The product is iron-free, nonhygroscopic and large in structure so that it can be supplied in any screen required. In addition to the sodium sulphate and salt cake, sodium chloride, a by-product of high purity, will also be marketed by Desert Chemical.



GLASS CUTTING AND FLARE FORMING MACHINE

The Eisler Engineering Company of Newark, N. J., has developed a new type high speed machine for making flares or funnels on the end of glass tubing. These flares are used in the production of incandescent lamps and have also found use in other glass fields where funnels on the end of glass tubing are being put through in large production.

The glass tubing is cut by an operator with a high speed carborundum wheel (a) and placed in the hopper (b) by the operator. From the hopper, they rotate completely automatically over a series of flames (c). When the tubings are sufficiently heated they contact the rotating reamer (d) which is operated by means of cams in and out as the tubes pass by. The finished flares are picked up by an automatic finger and rolled down the slide (e). From the slide they roll into the annealer (f) which is gas heated. This gas annealer is equipped with a set of chains drawn by a set of sprockets (g) running in opposite directions, making the flare rotate continuously over the entire surface of the gas flame. The gas flame anneals the flare, burnishes the ends and drops them into a chute (h). From there, they fall into standard working boxes as complete articles.

The machine is completely equipped with a gas and air mixing arrangement and requires a ¼ hp. motor. One operator can produce 1800 flares per hour. The production depends on the size of the flares and tubes used.

This machine can readily be adapted to many other glass uses that must rotate over the flames such as stirring rods, eye droppers and plunger buttons made from solid glass rods.

● George M. Dolan and C. S. Glenn have been named vice presidents of the Mathieson Alkali Works. Mr. Dolan, who is a director of Mathieson, was formerly assistant to Mr. E. M. Allen, president. Mr. Glenn will also retain his title as director of operations.

● The Chas. Taylor Sons Co., Cincinnati, Ohio, have appointed the Fire-Brick Engineers, Inc., 1548 West Bruce Street, Milwaukee, Wis., as sales representatives for the State of Wisconsin.

● Mr. Alphonse Wyss, Managing Director, Societe Continentale d'Appareils Mecaniques, announces the change of address of their offices from Basle to 7, rue Chailett, Fribourg, Switzerland.

INVENTIONS AND INVENTORS

(*Continued from page* 327)

Glass Wool and Fiber

Owens-Corning Fiberglas Corp. received patent 2,202,-030 (through assignment from Claus Siegfried of Dusseldorf, Germany) providing an apparatus for spinning glass threads. As shown in Fig. 4, small streams of glass flowing from the supply body are blown by conventional means so as to fall on a revolving drum from which they are withdrawn through a guide, 26, which condenses them into thread for winding on a spool. The drum takes the place of an endless belt used in some other processes. A suction is maintained within the drum.

New Products and Uses

Harold R. Owen of Los Angeles (Electrical Products Corp.) applied in patent 2,202,396 a plastic layer to glass tubing in a luminous display to obtain increase in strength.

Means of applying a glass facing unit were patented by Frank Clarke of St. Louis, Mo., (patent 2,200,382 to Pittsburgh Plate Glass Co.).

CORNING INSTALLS NEW FUEL TANKS

Fuel oil tanks are being installed in the Corning and Wellsboro plants of the Corning Glass Works to protect melting operations. The shortage of natural gas last winter brought operating difficulties which this new system is designed to offset. The tanks will have a total capacity of 920,000 gallons.

One of these, a 500,000 gallon tank, is being installed on the Fall Brook property to supply the Pressware and Fall Brook melting units, as well as for reserve. At the Main Plant, three tanks totaling 170,000 gallons capacity are being built underground. For the Wellsboro plant, a 250,000 gallon tank will be built.

A complete distribution system with piping, pumps, heaters, strainers and control apparatus is a part of each installation.

NEW MINERAL WOOL

One of the recent technical developments of the Anthracite Industries Fellowship at the Mellon Institute, is the production of mineral wool from anthracite colliery refuse and anthracite ashes. The process has been demonstrated on a semiplant scale with colliery refuse. Ashes need special treatment before use and therefore have not yet been subjected to large-scale tests; but the mineral matter in both is similar in character and chemical composition. Broadly, the waste material is mixed with limestone and burned in a special furnace to produce white mineral wool of good quality.

A CORRECTION

In the article "Bottles For Internal Pressure," by Frank W. Preston, in THE GLASS INDUSTRY for June, an error appeared in two of the equations on page 273, second column. The equations read $r = a = b \cos 2\theta$ while $q = 32$; also $r = a = b \cos \theta$ while $q = 29$. They should read $r = a - b \cos 2\theta$ while $q = 32$, and $r = a - b \cos \theta$ while $q = 29$.

IN GLASS POLISHING

THE USE OF AMERICAN FELTS IS TRUE ECONOMY

Leading manufacturers of glass rely on us to supply them with Polishing Felts which will give superior service and have longer, satisfactory life. Polishing costs less and goes along without hitches when American Quality Felt is used, because it has uniform density and increased absorption properties. Greater strength against strains and stresses of mounting felt on the polishing heads is another reason. Then, too, our Felt is put through a conditioning process which makes it ideal for beginning of the line and effects long life so that it performs satisfactorily at the important end of the line polishing.

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(*Continued from page* 311)

The above procedure was used with the fibers of the glasses to obtain the coefficients of expansion. From the ratios of the dial readings which were obtained, the expansions of the unknown glasses were read from the curve in Figure 7.

Using this method of determining thermal expansion, the coefficients of several glasses containing zirconia were found to lie in the range from 13 to 23 x 10^{-7} per degree Centigrade. Titania glasses possess higher coefficients, that of glass No. 20 being 41 x 10^{-7}.

[1] Important publications dealing with zirconia and titania in glass are as follows:

(a) "Transparent Zirconia-Containing Glasses." V. Dimbleby, S. English, E. M. Firth, F. W. Hodkin, W. E. S. Turner; *J. Soc. Glass Tech.*, Trans. **11**, 52 (1927).

(b) "Zirconium Oxide as a Constituent of Glasses," E. Preston; *Foote-Prints*, Vol. **11**, No. 2 (1938). (Foote Mineral Co., Philadelphia).

(c) "The Effect of Zirconium Oxide in Glasses, Glazes, and Enamels," C. J. Kinzie and C. H. Commons; *J. Am. Ceram. Soc.*, **17**, 283 (1934).

(d) "Some Observations on the Influence of Titania on the Properties of Glasses," A. R. Sheen and W. E. S. Turner; *J. Soc. Glass Tech.*, Trans., **8**, 187 (1924).

(e) "Titanium and Zirconium Compounds—Their Application in Enamels," and "Effect of Zirconium Oxide in Glasses and Enamels," C. A. Dutton and B. F. Wagner; *Cer. Ind.*, **24**, 24 and 108 (1935).

[2] See supplement to "A Compilation of Phase-Rule Diagrams of Interest to the Ceramist and Silicate Technologist," F. P. Hall and H. Insley; *J. Am. Ceram. Soc.*, **21**, 113 (1938).

[3] These crucibles were about 1 in. in diameter and 3 in. high. They were cast in plaster-of-paris molds from a mixture of 90 per cent zirconium silicate with 10 per cent Mississippi pot clay which had been ground in a ball mill with the addition of 25 per cent water plus 0.1 per cent of an electrolyte consisting of equal weights of sodium carbonate and sodium silicate. The crucibles were fired to Cone 20 (1530° C).

[4] Alloy No. 502 from Hoskins Mfg. Co., Detroit, Mich.

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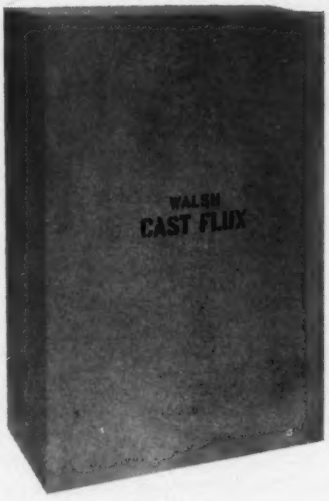
WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

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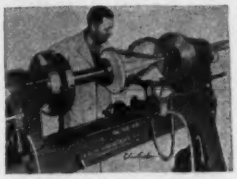

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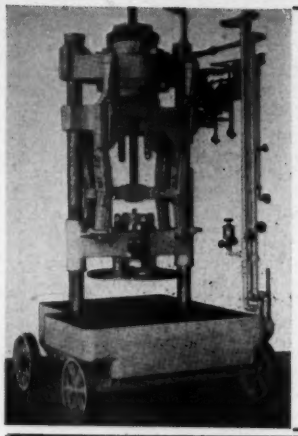

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